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V.

CORRELATIONS BETWEEN MENTAL CAPACITY AND BRAIN COMPLEXITY IN TWENTY CASES OF FEEBLE-MINDEDNESS.

(WAVERLEY RESEARCH SERIES, CASES I–XX.)

WITH GENERAL CONCLUSIONS CONCERNING THE GENESIS OF CERTAIN CASES.

E. E. Southard, M.D. and O. J. Raeder, M.D.

The plan of the present article is (a) to make a provisional epicritical review of the problems presented by ten cases (XI–XX) of the Waverley Research Series of cases of feeble-mindedness presented in the previous article of this series. Brief characterizations of these ten cases were given at the end of the previous article; but I here mean to bring more general conclusions resembling those of Article III of these researches, namely the article entitled "Neuropathological Correlations with Clinical and Psychometric Findings in Feeble-mindedness."

I intend (b) to make mutual comparisons not merely between the cases (XI–XX) of the present publication but also of the entire twenty so far reported (Waverley Research Series I–XX). The conclusions must in their nature be tentative, and the editors of the Waverley Researches have all along maintained that no very fundamental conclusions could be hoped for until at least fifty cases have been examined. If the pathologist working in another field than neuropathology is pleased to wonder at the slow pace of such researches, let him consider the number of factors involved and remember that the lamented Hammarberg in his masterly monograph was able to deal with but nine cases and that most of Hammarberg's work in 1895 consisted in determinations of normal features of the brain by way of background for his studies in feeble-mindedness. A like fragmentary view of the whole topic is presented in the great work of Bourneville, in that of Mierzejewski and in the orientation work done here in America by Wilmarth. It is a question whether this series can be completed in its present form in the next few years although the anatomical, photographic and histological work is now advanced through the third and into the fourth series of ten cases.

It is the province of these epicritical articles, interpolated in the series of articles embodying details, to develop in current fashion such ideas as the cases suggest and to strip the husks off the larger problems that future research may undertake. Perhaps the most striking result afforded by the work to date is illustrated in the last plate (Plate XXXII of this publication), a plate showing the twenty brains in two orders highly suggestive of fairly close correlation between mental capacity and brain complexity. It is on this account that the title of the present article has been made to stress the matter of correlation between brain and mind.

Before proceeding to the epicritical review, I may rehearse the general situation presented in the first publication of the Waverley Researches in 1918.

1. That the world ought to have available for conclusions far more properly reported cases of feeble-mindedness with autopsies than are at present at hand, goes without saying. As before remarked, the literature probably contains less than 100 comparable cases (Tredgold's book is founded upon about a dozen cases; many of Bourneville's cases are curiosa). The present series now approaches fifty in the course of study.

2. The practice of systematic external photography and photography of the sectioned brain has been continued. But for the present series photographs reproduced in various degrees of magnification have been used to bring out different points. Attention may be called to the presentation of twenty brains in two orders (psychometric and encephalometric) reduced to very small size (of course all these brains are available in photographs of a much larger size). These photographs made by an expert photographer, Mr. Herbert W. Taylor, are available in enlargements, about twice the size of the original brain for class demonstrations and are at the Massachusetts School for the Feeble-minded and at the Harvard Medical School.

3. The practice of making total brain sections of these brains has been continued; but most of the conclusions concerning the histology of these cases have been drawn from specially cut and stained smaller sections.

4. The "Mierzejewski effect" was mentioned at the end of Article I in the previous publication of 1918, that is, the problem afforded in certain cases of disharmonious development of grey and white matter (grey in excess) in which the commissural system is thought to be deficient. Some attention has been paid to this defect in the present series and casual notes upon it may be found in the description of the photographs printed just before the plates in the present publication.

5. The idea attributed to Dejerine that intellectual capacity may depend more upon cell interconnections than upon cell numbers is an idea which it has not been found possible to pursue though the situation depicted in the last plate (Plate XXXII) shows certain disparities of position in the brains arranged by mental capacity as compared with the

brains arranged by brain complexity. Thus, if "Little Zip's" brain (Case III of the total series) and the able-bodied imbecile's brain (Case IX of the total series) weighed about one pound and about three pounds respectively and if the mental ages of these two patients were approximately equal, then a careful histological comparison of these two brains would yield interesting results upon the question of the Dejerine effect. But to accomplish this correlation would require resources of technique and workers beyond the powers of any institution yet established in the world.

6. The Hammarberg query as to the probable date of origin of various maldevelopments and arrested developments is a query whose answer would have the most profound bearings on education. Perhaps the case we often term the loaf-of-bread case (Case XVI) would be significant here if we could by a combination of arguments from pathology and embryology decide exactly when in the embryonic life this lesion began. If there are two rows of Betz cells in this most remarkably undifferentiated brain, were there two periods of activity in the development of these cells such that one group of cells got more "drive" into the tissues than did the other and what relation does the comparatively well-developed corpus callosum bear to the rest of the brain development?

7. The question of an exact definition in cerebral terms of "plastic impotence" (agenesia) and "plastic arrest" (aplasia) gets some assistance from the present series. Cases with approximately equal degrees of nerve cell scarcity as quantitatively estimated — no one seems able as yet to make exact quantitative comparisons in this direction — may be cases (a) of acquired cell loss, (b) of initial cell lack, (c) of combinations of acquired cell loss and initial cell lack. Some little help is afforded by the degrees of gliosis in these brains, especially if we find a close relation between the gliosis and the nerve cell scarcity in the different areas. And some authors feel that we can attribute some value to the irregularity of disposition of nerve cells on the reasoning that an irregular disposition of nerve cells means some sort of lesion acquired by the brain subsequent to the laying down of the cells. We have felt that a pronounced heterotopia, dislocation or translocation of nerve cells was indirect evidence of aplasia rather than agenesia, arguing that these translocations meant differing amounts of initial "drive" on the part of the cells as laid down. Accordingly, in cases with equal degrees of cell scarcity we have tipped the scale towards aplasia when there was definite evidence of heterotopia.

8. As for the problem of so-called "functional feeble-mindedness" there is little new to report from this series, though possibly the data from Mongolian brains will bear on the question (one of the Mongolian brains with a low brain weight seems to have been credited with a higher mental age than a Mongolian brain of higher brain weight).

Let us now arrange the twenty brains in tabular form in several ways.

First let us present a table (Table VIII) displaying features as in Table II of the publication of 1918 but relating to Cases I–XX rather than I–X.

TABLE VIII.

Number	Age	Mental Age	Brain Weight probably	Focal Destructive Lesion	Hydrocephalus	Exudative Lesion of Rod Cells	Nerve Cell Aplasia	Fibre Loss	Gliosis	Satellitosis	Dislocated Ganglion Cells
I	5	1–, est.	minus	0	moderate	0	marked	marked	slight	0	0
II	20	1–, est.	minus	+	marked	0	marked	marked	marked, patchy	+	0
III	45	7, est.	minus	0	0	0	+	?	+	+	0
IV	62	moron or subnormal	plus	0	+	+	+	+	+	focal	+
V	16	subnormal	normal	0	slight	0	+	0	+	0 (sl) focal	+
VI	26	2, est.	minus	0	0	+ rod cells	slight	?	+	+	0
VII	25	5, Binet	normal	thrombus (hist.)	0	rod cells	slight	?	+	0	0
VIII	36	subnormal	normal	0	0	+	+	0	+	+	+
IX	39	7, Binet	plus	0	0	0	+	0	0	0	+, slight
X	37	2.4, Binet	plus	0	0	?	+	?	+	+	0
XI	5-10/12	1.2	820	+	marked +	+	+	+	+	0	0
XII	20	3.4	2325	0	marked +	plasma +	0	+	+	0	0
XIII	18	3.1	1160	0	0	rod cells	+	0	+	0	0
XIV	32	1.3	1205	0	0	+ plasma	+	0	+	+	+
XV	43	2.4	1070	0	0	+ plasma	0	0	0	0	0
XVI	14	1.0	950	0	0	rod cells	+	0	+	+	0
XVII	31	7.0	1275	0	0	+	+	0	+	+	0
XVIII	9	1.0	1475	+	moderate	+ Meninges: rod cells	0	+ marked	+	0	+
XIX	23	5.2	910	+	0	+	+	0	+	+	0
XX	38	6.0	1390	+	0	+	0	0	+	+	0

In the second series there are no additional cases of pronounced microcephaly. The three cases in the first series (cases I, II, III) bear much the same relation to the combined 20 brains of the 1st and 2nd Series as they did in the 1st Series. They remain at the lower end of the anatomical scale, the third (Case III) alone being displaced in order by Case XVI as of more simple pattern. Case III psychologically still stands out prominently from his anatomical class ranking sixteenth in the combined series of 20 (Plate XXXII). The two smallest brains of the 2nd Series, Cases XVI and XIX, are mildly microcephalic.

In case XVI the "loaves of bread" brain of uniquely simple pattern, the Binet correlation is regular, a simple brain with a simple mind. Case XIX of about the same weight but with much more complex sulcation also rates consistently higher on the Binet scale.

However, weighing but 910 grams and of not a very complex pattern, the psychological rating seems high even at 5.2.

Hydrocephalus was marked in cases XI and XII and moderate in Case XVIII. The evidence of syphilis could not be disentangled from the evidence of tuberculosis in Case XI and therefore the syphilogenic hypothesis of hydrocephalus gains no support here. The other two cases — Cases XII and XVIII — do show much incriminating evidence for syphilis. A prolonged research over more uncomplicated cases is needed to settle this important question. It is certainly of frequent occurrence in hereditary syphilis.

Focal destructive lesions were found in four instances, Cases XI, XVIII, XIX and XX. All these cases also showed exudative changes, in fact the number of cases in the second series is much larger than in the first series, every case (cases XI to XX inclusive) showing exudative products in one form or another. These cases likewise were drawn from a chronic class of institution cases.

Case XVIII yielded the most unusual form of focal destructive lesion in the form of multiple cysts found throughout the white matter of the brain. Convincing histological evidence of syphilis was found. The hydrocephalus which was also present and the cystic degeneration of the white matter seems to suffice for the considerably lower psychometric rating of this case.

Case XIX, one of the Mongolians, showed slight focal degeneration in a few areas, though it was not convincing for syphilis. Case XX with mononucleosis and radiating gliosis in focal distribution, however, bids fair to be syphilitic.

In fourteen cases nerve cell aplasia was evident enough for consideration. In 13 of them gliosis occurred with fair regularity. This might lead us to argue that plastic arrest is a more common factor in feeble-mindedness than has heretofore appeared and thus a more hopeful outlook to treatment, or rather prevention is at hand.

The occurrence of heterotopia in six cases — Cases IV, V, VIII, IX, XIV and XVIII — all brains of a comparatively good appearance grossly (with possible exception of cases IX and XVIII) gives significant warning that the microscopic anatomy must be considered when matching brain and mind.

In the next table (Table IX) the brains have been arranged in the order of their estimated complexity. A comparison with the mental ratings will serve to illustrate the difficulty of correlating brain anatomy with brain physiology.

TABLE IX.

COMPARISON OF BRAIN COMPLEXITY, BRAIN WEIGHT, AND ORDER OF INTELLIGENCE IN CASES I–XX.
(Arranged in Order of Brain Complexity.)

Number	Age	Brain Complexity	Brain Weight	Intelligence
I	5	a)	400–, est.	1–, est.
II	20	b)	620	1–, est.
XVI	14	c)	950	1, Binet
III	45	d)	610	7, est.
XI	5	e)	820	1.2, Binet
XII	20	f)	2325	3.4
VI	20	g)	1130	2, est.
XVIII	9	h)	1475	1.0
X	37	i)	1450	2.5, Binet
IX	39	j)	1620	7, Binet
XX	38	k)	1390	6, Binet
XV	43	l)	1070	2.4, Binet
VII	25	m)	1270	5, Binet
XIX	23	n)	910	5.2, Binet
XIII	18	o)	1160	3.1, Binet
XIV	32	p)	1205	1.3, Binet
IV	62	q)	1340	Moron or subnormal
XVII	31	r)	1275	7, Binet
V	16	s)	1435	Subnormal
VIII	36	t)	1340	Subnormal

For this purpose the reader is referred to the last plate (Plate XXXII) of this series. Here it is graphically shown that Little Zip (Case III) got by far the most intellectual return per gram of brain weight. The best "camouflaged" brain on the other hand is that of case XIV, a large, fairly complex brain which when viewed through the microscope disclosed an idiot intellect (Binet 1.3). As stated above, consideration of the brain weight and brain pattern is not sufficient in estimating the mental capacity of a certain brain.

Case XIX, the dolichocephalic Mongolian with generalized aplasia, probably showed the best mind per gram weight of brain (910 grams) next to Little Zip. The same comparison made with the other Mongolian brain, Case XIII, next in order of complexity, is even more emphatic because the brain weight of Case XIII is greater by 250 grams (1160 grams) and this case attained to a mental grade of only 3.1 as of 5.2 for the smaller brain of Case XIX. The question of "functional" feeble-mindedness arises here and one might logically ask what rôle an endocrinopathy might play in these cases.

TABLE X.

COMPARISON OF BRAIN WEIGHT, CORRECTED BRAIN WEIGHTS, AND ORDER OF INTELLIGENCE IN CASES I–XX.
(Arranged in order of actual brain weight.)

Number, Age, Height (cm.)	Brain Weight Tigges	Brain Weight Age normal	(Sex)	Brain Weight Actual	Intelligence
I, 5, 81	648	1282	M	400, est.	1–, est.
III, 45, 126	1008	1348–66,	M	610	7, est.
II, 20, subn.	?	1358–96,	M	620	1–, est.
XI, 6, 102	816		M	820	1.2
XIX, 23, 160	1280		M	910	5.2
XVI, 14, 128	1024		M	950	1
XV, 43, 152	1216		M	1070	2.4
VI, 26, 158	1264	1358–96,	M	1130	2, est.
XIII, 18, 139	1103		F	1160	3.1
XIV, 32, 159	1272		M	1205	1.3
VII, 25, 146	1168	1234–39,	F	1270	5
XVII, 31, 160	1280		F	1275	7
IV, 62, 141	1128	1178–1210,	F	1340	Moron or Subnormal
VIII, 36, 179	1432	1365–6,	M	1340	Subnormal
XX, 38, 168	1344		M	1390	6
V, 16, 168	1344	1358–96,	M	1435	Subnormal
X, 37, 144	1152	1365–6,	M	1450	2.4
XVIII, 9, 115	920		M	1475	1
IX, 39, 178	1424	1365–6,	M	1620	7
XII, 20, 148	1184		F	2325	3.4

Table X presents the 20 cases in the order of brain weight. For comparison the brain weights as estimated by Tigges' formula (eight times the body length in centimeters equals the brain weight in grams) and the normal weights for given age and sex (Vierordt's statistical tables) are placed in parallel columns.

TABLE XI.

COMPARISON OF ORDER OF INTELLIGENCE WITH COMPLEXITY OF BRAIN IN CASES OF I–XX.

Number	Actual Age	Intelligence	Brain Complexity	Remarks
I	5	1–, est.	a)	
II	20	1–, est.	b)	
XVI	14	1	c)	
XVIII	9	1	h)	
XI	6	1.2	e)	
XIV	32	1.3	p)	
VI	26	2, est.	g)	Vocal cord absent
XV	43	2.4	l)	
X	37	2.4	i)	
XIII	18	3.1	o)	
XII	20	3.4	f)	Brain weight 2325!
VII	25	5 (2–3)	m)	
XIX	23	5.2	n)	Insane Imbecile
XX	38	6	k)	
IX	39	7	j)	
III	45	7	d)	"Little Zip"
XVII	31	7	r)	
IV	62	Moron or Subnormal	q)	Almshouse transfer
V	16	Subnormal	s)	Dementia Praecox
VIII	36	Subnormal	t)	Murderer

Table XI lists the cases of the combined series according to the estimated intelligence. A combination of this table and table IX has resulted in the construction of Plate XXXII which presents these relationships in more graphic form.

A comprehensive macroscopic review of the 2nd series, Cases XI to XX, is given in table XII, including the bony and fibrous coverings of the brain together with brief information about the cerebellum and spinal cord.

From a careful consideration of Plate XXXII, some difficulties of our first problem, matching brain complexity with testable mind are brought forth in bold relief. It will be readily seen that the microcephalics in a general way represent the lowest intellects and the larger brains rest on the higher intellectual planes. But more striking is the fact that the more complex brains rate higher with some exceptions than the simpler patterns. In other words gross brain defects correlate readily with idiot and low-grade-imbecile intelligence and very complex looking brains correlate with moron and slightly subnormal minds. Of the combined series of 20 brains, 12 cases, mostly at the ends, correlate between brain complexity and testable mind is readily demonstrated. But certain glaring exceptions are perceived with equal facility.

If now the microscopical anatomy of these exceptional cases be considered, an additional number of cases can be correlated. The marked focal heterotopia of Case XIV at once unmasks this seemingly complex brain and brings it much more closely to its place in the anatomical order indicated by its low Binet. A similar adjustment follows in Case XVIII when the cystic degeneration and hydrocephalus are found in section. The exudative lesions and other evidence of syphilis not visible in the gross are sufficient to make a satisfactory correlation.

The case of Little Zip remains as before, unexplainable. With the light of further research both of a much larger series of cases and a much finer histological examination apparent discrepancies between brain and mind may be partially cleared.

The question of theoretically preventable feeble-mindedness receives some help, apparently, from the Second Series. The question of syphilis comes up strongly in Cases XII, XX and positively in Case XVIII; to a less extent but strongly suspicious in Cases XIV, XV and XIX. This would seem to be too high a percentage of syphilis. In a nosological study of 100 autopsied cases of feeble-mindedness in which these two series were included, O. J. Raeder found 15% with strongly presumptive evidence of syphilis.

Case XVIII was theoretically preventable and possibly Cases XII and XX also.

In Case XIV the infectious etiology (scarlet fever) is again strongly suspected. The symptoms are said to have dated from the time of the fever, beginning with abasia possibly of central toxic origin.

Cases XIII and XIX, the two Mongolians, if this peculiar and well delineated feeblemindedness be solved by the endocrinologist, would probably be helped at least by organotherapy. Extensive and fundamental research in a large series of autopsied cases of carefully studied Mongolian Idiots would no doubt help greatly to solve this important problem. Metabolism studies with functional observations and attack along the lines of röentgenology to show bone development and histochemistry would seem to be indicated.

The second series is replete with neurological lesions worthy of special attention. The most striking abnormity is Case XVI, the "loaves of bread" brain. The almost complete lack of sulcation on top resembling the picture of a foetal brain, makes for a brain pattern than which no simpler example has come to our knowledge. The irregularity or focality of this macrogyria one might almost say agyria confined to the top and slightly more to the right side is noteworthy. For in the temporal convolutions complication advances rapidly, whereas by the base posteriorly one would hardly recognize the same brain. On section the centimeter thick cortex over the frontal lobe halts the eye. On microscopical examination the absence of lamination and homoplasia of cells is no less striking. Two distant rows of Betz cells were found. There was no suggestion of Vignal's layer in the cerebellum. One sees here a thickly laid cortex rich in cells that has not been spread out. With the development and differentiation of the normal cortex laminations, the formation of gyri and spreading out of the cortex would have followed.

The peculiar reaction to syphilis in case XVIII resulting in cystic degeneration with cell proliferation about small vessels in the white matter has already been noted. The transversity of the Rolandic fissures especially at the upper end in the Mongolians (Cases XIII and XIX) with relative shortening of the frontal convolutions is noteworthy since it has been observed in other cases of the next series. In many instances the formation of generally regarded chronic changes, mononucleosis for example, were found after infection of short duration (weeks). In Case XII the blocking of the aqueduct of Sylvius by neuroglia tissue apparently was a cause of the marked hydrocephalus.

Studies of the commissural system are suggested as one observes such cases as Case XVI mentioned above where in spite of the poorly developed cortex cells the corpus callosum is remarkably well formed.

TABLE XII.

Case Number	Calvarium	Dura Mater	Pia Mater	Vessels	Brain Weight Grams	Gyri	Diffuse Atrophy or Aplasia	Focal Atrophy or Aplasia	Corpus Callosum
XI	Thickest by longitudinal fissure; left frontal eminence prominent	Adherent except at vertex	Focal duropial adhesions; fibrinous exudate at base (tuberculous)	Negative	820	Hydrocephalus	Marked	Right more atrophic	Translucent membrane
XII	Wormian bone; right side larger	Focal adhesions to pia	Focal adhesions	Negative	2325 (Probably app. 1000-fluid	Hydrocephalus	Marked	Aplasia of 2nd rt. frontal and hippocampal	Thin
XIII	Fontanelle thin; other irregularities in thickness	Adherent by longitudinal fissure, esp. left	Olfactory nerves adherent	Basilar small	1160	Asymmetries marked	Absent	Depressions orbital surfaces Minor anomalies	Posterior ⅔ thin
XIV	Dense without diploe	Thickened by longitudinal fissure & along middle meningeals	Focal thickenings, vertical. Focal edema Exudate basal. Adhesions about the 4th ventricle	Posterior cerebrals unequal	1205	Fissuration simple	Cerebellum exposed	Right parietal small	Slightly thin in posterior third
XV	Scalp adherent	Adherent Mid. vertex thick and yellow, pacchionian bodies	Basal thickenings irregular, thick along vessels. Slight focal edema	Negative	1070	General gliosis anomalous fissuration	Absent	Both temporals narrow	Mid. portion slightly thin
XVI	Negative	Negative	Sl. thickening about 3rd nerves	Negative	950	Macrogyria	Deficient fissuration	Absent	Normal looking
XVII	Negative	Slightly thick over vertex and middle	Sl. cloudy over vertex. Edema parietal and central. Sl. acute exudate base	Small somewhat white	1275	Complex	Absent	Absent	Slightly thin posterior ⅔
XVIII	Negative	Adherent throughout	Cloudy esp. left and anteriorly	Left vertebral small	1475	Pattern fairly rich	Atrophy present	Left orbital	Generally thinned out
XIX	Thin	Negative	Slight thickening basal	Negative	910	Minor anomalies	Aplasia present	Absent	Not remarkable
XX	Negative	Thick	Sulcal thickenings & basal thickening	———	1390	Fairly complex minor anomalies	Absent	Depressions prefrontal	Thin posterior third

TABLE XII (*continued*).

Middle Commissure	Consistence	Sclerotic Foci	Other Foci Destructive	Ventricles Hydro-cephalus	Cerebellum	Spinal Cord	Remarks
Absent	Left hemisphere firmer than right	Absent	Absent (tuberculous meningo encephalitis)	Chronic internal hydrocephalus	Left side firmer than right	Tuberculous meningitis	
Absent	Normal	Absent	Temporal tips parchment like	Chronic internal hydrocephalus	Small also pons	Negative	Pituitary small; choked discs
——	Not remarkable	Absent	Absent	0 or slight	Negative	Thoracic hemorrhage	Clinoid processes peculiar Pituitary fibrosis
Present	Slight increase esp. frontal	Absent	Absent	0	Negative	Negative	Clinoids peculiar Optic discs unequal
Present	General increase	Hippocampals esp. firm Pons and bulb firm	Absent	0	Negative	Negative	Olfactory tracts thin
Probably absent	Soft	Absent	Absent	0	Negative	Soft	Gasserian ganglia small
Present	General increase superiorly	Absent	Absent	Granulation 3rd slightly 4th	Negative	Negative	Cyst pineal
——	Generally increased	Absent	Numerous cysts	Present probably ex vacuo	Firm	Firm	——
——	Not remarkable	Absent	Absent	Absent or slight	Negative	Negative	Olfactory bulbs thin
——	Increased	Absent	Absent	Absent	Negative	Firm	——

SUMMARY.

The provisional conclusions drawn from the second series and the combined first and second series are much in agreement with the original conclusions drawn from the first Series which were as follows.

First that measurable brain can be correlated with testable mind in the low and high orders with fairly positive results. That is the small simple brains represented the low intellects or idiots and the most complex brain patterns corresponded to the high grade, moronic and subnormal types of feeble-mindedness. Some glaring exceptions (Case III) still defy solution, whereas others (Case XIV) are replaced nearly to their proper anatomical level by microscopic examination.

Secondly, the matter of secondary or preventable amentia is also given much support in the second series, all but one case showing some evidences of exudative lesion, the evidence of syphilis not the least prominent.

The fact that the double series has upheld the original provisional conclusions gives some hope that a much larger series will yield still more conclusive findings.

NOTE REGARDING PLATES OF SERIES XI–XX.

In this series, XI–XX, the scheme of presenting six surface views including top, base, right and left side views and two mesial surface views of each case in uniform size, conduces to a more ready comparison.

A second plate pictures the gross brain sections in like manner. In addition enlarged views of some of the surface views and sections have been given to emphasize particular lesions.

DESCRIPTION OF PLATES.

Views of Case XI.

The extreme hydrocephalus, greater in the left hemisphere (compare XI–b left side with XI–c right side) is at once indicated by the irregularity in the shape of the brain, resembling a partially collapsed balloon. This is also shown in the folds in XI–a, XI–b, and XI–c, and the puckering indentations of the temporal tips in XI–d. On mesial section the dilated ventricles (padded with cotton fibre) XI–e, XI–f, attest to the marked hydrocephaly. Note the thin corpus callosum.

The shallowness of the sulci as indicated by their stenciled appearance is seen in all the surface views. The sulcal markings in the views XI–b and in the next case, XII–a, remind one of the anthracotic markings on the surface of an old lung. In XI–a a piece of adherent dura gives evidence of the terminal meningitis (tuberculous).

The dilatation of the ventricles and shallow sulci are more conclusively shown in the gross section photographs XI–g to XI–n. In XI–m and XI–n one notes that while the left ventricle is stretched to a greater degree there is a greater amount (thicker wall) of grey and white matter on the left.

The thinned out corpus callosum in this case and the next (Case XII) when considered in conjunction with the relatively lessened amount of white matter might give some support to the Mierzejewski theory of deficient commissural fibres.

Views of Case XII.

Another case of marked hydrocephalus, in many respects similar to Case XI, but probably not quite so extreme. In XII– the irregular dilatation of the two hemispheres is noted, greater in the left posterior and right anterior cornua of the ventricles. This is also brought out in the cross-sections XII–i (lower section) compared with XII–j where the greater dilatation is on the opposite (left) side.

Note again the shallow fissuring both as seen from the surface and in the gross sections.

Note also the remarkable fenestration of the septum pellucidum XII–e and XII–f giving the arachnoid appearance of a lacy curtain.

Views of Case XIII.

A fairly large (1160 grams) round brain of a Mongolian idiot. The left hemisphere is larger than the right (XIII–a, XIII–b and XIII–e). One is struck by the transversity of the upper ends of the Rolandic fissures (XIII–a). This places them farther front and shortens the frontal gyri, especially the first and second frontal considerably. This transverseness or forward placement of the Rolandic fissures with resultant shortening of the frontal convolutions and increase of post Rolandic areas, especially in the superior parietal regions, is evident in other Mongolian brains (Case XIX) of this series (and Cases XXI, XXVII, and XXIX of the 3rd series).

The large brain sections were not remarkable and have been omitted.

There is inequality in the post and precentral gyri of the two sides (XIII–a, XIII–b and XIII–c) and the right pre- and post-central gyri considered as a whole are smaller than the left pre- and post-central taken together.

There is a tendency to macrogyria in the frontal and parietal areas and possibly in the right occipital. In the left occipital region the gyri are small, as are also both first temporal convolutions (XIII–c and XIII–d), the left one being irregular and moniliform in outline.

The brain pattern in general is relatively simple; the smaller sulci being mostly absent or poorly developed.

Views of Case XIV.

This is a comparatively large brain of unusually complex pattern for such a low mentality (Binet 1.3). There are, however, certain irregularities and inequalities. The posterior two thirds of the brain appear somewhat small for the rather large rounded anterior lobes (XIV–a, XIV–b, and XIV–c). This may account for the protrusion of the cerebellum behind.

The postcentral gyri are unequal, the left in general larger and thicker than the right (XIV–a). The first temporal on left shows a marked irregularity, its fellow being better developed.

The right temporal tip is broader and more rounded coming much nearer the center line (XIV–d). The lobus pyriformis on the left appears larger (XIV–d).

The gross sections (XIV–g to XIV–n) show a fair proportion of white and grey and deep (not abnormal) sulcation. There is no hydrocephalus.

Evidence for the most part in this brain is found in the microscopy, viz., in the marked heterotopia and focal aplasia of ganglion cells.

Views of Case XV.

Photographs XV–a, XV–b, XV–c, XV–d picture a fairly complex looking brain, so much so that the central gyri are outlined with difficulty (XV–a).

The first temporal gyri are irregular (XV–b and XV–c). The left is small and shortly lost. The right is much larger and well developed.

The corpus callosum shows some thinning in the middle third (XV–e and XV–f, and less distinctly in XV–i and XV–j).

The ventricles are slightly enlarged probably not from distention, but lack or aplasia of brain wall.

The most convincing argument for feeble-mindedness in this case lies in the microscopical picture, namely, the marked aplasia in some regions.

Views of Case XVI.

This brain macroscopically one of the most remarkable of the whole series. The extreme anisogyria top (XVI–a) compared with base (XVI–b). The marked macrogyria is confined to the top (XVI–a) and front (XVI–b and XVI–c) mostly. In the temporal lobes and occipital lobes and on the base gyration comes nearly to normal in appearance. The left hemisphere is shorter. The left gyrus rectus (XVI–d) is unusually large. The corpus callosum is relatively large (XVI–e, XVI–f, XVI–h, XVI–i and XVI–k).

The enormous thickness of the cortex (XVI–h, XVI–i, and XVI–k) is shown corresponding to the macrogyria (XVI–a, XVI–c and XVI–d), and likewise the more normal cortex is seen where the cells microscopically begin to show lamination. There is also a slight enlargement of the ventricles, most likely due to aplasia of the surrounding brain matter. The correlation of marked heterotopia with the undeveloped cortical lamination is noteworthy.

Views of Case XVII.

The brain pattern is complex (XVII–a); there is a striking defect in the first left frontal convolution near the vertex. The temporal lobes are well rounded, especially the tips (XVII–d) though separated. The occipital poles are somewhat small (XVII–b) especially the right (XVII–c). The corpus callosum (XVII–k, XVII–l, XVII–o) is fairly large though somewhat thinner in the posterior third (XVII–j and XVII–k and XVII–l). The gyral tips tend to point rather than round off especially in prefrontal region.

The most convincing evidence for feeble-mindedness is in the microscopic picture, namely, the aplasia and gliosis.

Views of Case XVIII.

A fairly large brain (1475 grams) but a considerable degree of hydrocephalus (XVIII–h, XVIII–i and better XVIII–j, XVIII–k, XVIII–l and XVIII–o). Externally the atrophy of gyri separated by wide sulci is the most prominent feature (XVIII–a, XVIII–d and XVIII–e, XVIII–v). The crura appear shrunken away from the hippocampal gyri (XVIII–i). The marked asymmetry of the temporal tips is also noted here (XVIII–i), the left being smaller and acuminate. There is marked thinning of the corpus callosum, especially in middle and posterior third, (XVIII–h, XVIII–i and XVIII–l, XVIII–s, XVIII–t). This case again as in cases XI and XII, bring up the question of a deficient commissural system, the so-called "Mierzejewski effect."

Remarkable is the cystic degeneration in the white matter (XVIII–m, XVIII–n, XVIII–o, XVIII–p. See also micro-photographs XVIII–u, XVIII–v, XVIII–w).

Further evidence of feeble-mindedness is found in the cell pictures, viz., heterotopia, granular degeneration and exudative products.

Views of Case XIX.

This is a small (910 grams) Mongolian brain, the second of the series (see Case XIII). The brain pattern is relatively simple and there is moderate macrogyria. The forward placing of the Rolandic fissure inclining toward a transverse direction with resultant shortening of the frontal convolutions, is again evident (XIX–a) though not quite so marked as in Case XIII. There is little cross fissuring in the post-central gyri which are smooth and regular. The pre-central gyri are both crossed by deep transverse fissures (XIX–a, XIX–b, XIX-c). The occipital poles are unusually plump and well developed (XIX–b, XIX–c and XIX–e, XIX–f). The temporal tips (XIX–h) are somewhat asymmetrical, notching of the left. The right cuneate lobule (XIX–f) is slightly larger and more complex than the left (XIX–e).

There is probably a slight dilatation of the ventricles (XIX–k, XIX–l, XIX–m and XIX–n).

Views of Case XX.

Large fairly complex brain of an imbecile (XX-a). A considerable number of developmental irregularities, however, are shown. The right hemisphere (XX–a) has a much simpler pattern than the left, especially marked in the parietal and less in the superior frontal regions. The precentral gyri are deeply cross fissured. On the left the first frontal convolution suppresses the upper end of the precentral convolution entirely.

The right occipital lobe is larger than the left (compare XX–b and XX–c). Note also this relation in the cunei (XX–e and XX–f). The corpus callosum is somewhat thinned posteriorly (XX–m).

PLATE XXXII.

Correlating Brain Complexity with Mental Capacity.

In the lower part of the figure, miniature reproduction of the 20 brains of the combined Series I and II, are arranged in anatomical order. In the upper group the same brains are arranged according to Binet intelligence values. The extent to which it has been possible in this short series to match measurable brain with testable mind is shown by the lines connecting the anatomical and psychic levels of each case.

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NOTE — This bibliography is a continuation of the bibliography given in the 1st series, to which the reader is referred for the years 1860 to 1915 inclusive. The bibliography is founded on the card catalogue of the Massachusetts School for Feeble-minded at Waverley and is selected. Unimportant articles have been omitted and an endeavor has been made to include especially studies of a pathological nature and such psychological and clinical works that appear to advance our knowledge of Feeble-mindedness.

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